Foliar nutrition for HLB

By Timothy M. Spann, Arnold W. Schumann, Bob Rouse and Bob Ebel

Why the foliar nutrition approach to managing huanglongbing is a viable option for Florida

To say that there has been controversy surrounding the management of huanglongbing (HLB) infected trees with the application of foliar nutrition is an understatement of epic proportions. This controversy first began in early 2006 when it became common knowledge within our industry that Maury Boyd had made the decision that HLB-infected trees would not be removed from McKinnon Corp. groves. This decision was counter to the prevailing scientific opinion at the time, which said that the removal of HLB inoculum by cutting down infected trees was the only viable strategy to manage HLB. However, Boyd believed that the infection level was already so high in his grove in spring 2006 (a mere six months since the first confirmed find near Homestead) that removing inoculum would mean removing the entire grove.

In this article, we present the case for the use and continued study of foliar and soil-applied nutrition programs to manage HLB-infected trees in Florida by looking at the factors that got us to where we are today, the unique circumstances that exist in Florida, and preliminary data on the effect of foliar nutrition programs.

HISTORY LESSON

When people think about HLB in Florida, many start the story in August 2005 when the first infected tree was discovered near Homestead. However, the story really began in 1998 when the Asian citrus psyllid (ACP) was first found in Florida. This tiny insect is the only known vector in Florida of *Candidatus* Liberibacter asiaticus, the bacteria believed to cause HLB.

In the absence of HLB, ACP is a relatively minor pest of citrus, and since it was believed that HLB was not present in Florida in 1998, rigorous ACP control was not commonly recommended nor initiated by growers. In hindsight, that was a serious mistake. From 1998 to 2005, ACP spread throughout all of the citrus-growing areas in Florida and populations grew to very high levels. The movement of both citrus trees and ornamental alternative hosts (e.g. orange jasmine/*Murraya paniculata*) probably contributed to the rapid spread of ACP.

It is generally believed that sometime during this period, HLB was unknowingly introduced to Florida. However, it is possible that HLB was here, surviving in some poorly managed backyard or abandoned trees, prior to the arrival of ACP. Although the exact sequence and timing of events is unknown, what is known is that once we knew we had HLB and started looking for it, the disease was everywhere. The maps in Figure 1 show the progression of HLB in Florida over the 26 months from August 2005 to October 2007. There's little argument that the "spread" depicted in these maps was not occurring in real time; rather, the HLB finds by the state inspectors were merely recordings of history. The actual infection probably occurred one, two or even more years prior to the symptomatic trees being found.

The argument can be made that this series of events caused us to lose the war before the first battle had begun.

UNIQUE CIRCUMSTANCES IN FLORIDA

The authors believe that several factors existed in Florida that contributed to the rapid spread of HLB and continue to hinder our efforts to fight this disease. The first of course is the relatively uncontrolled population boom of the vector that we've already discussed. However, our climate, abandoned groves, poorly managed backyard trees and location are other important factors we'll discuss.

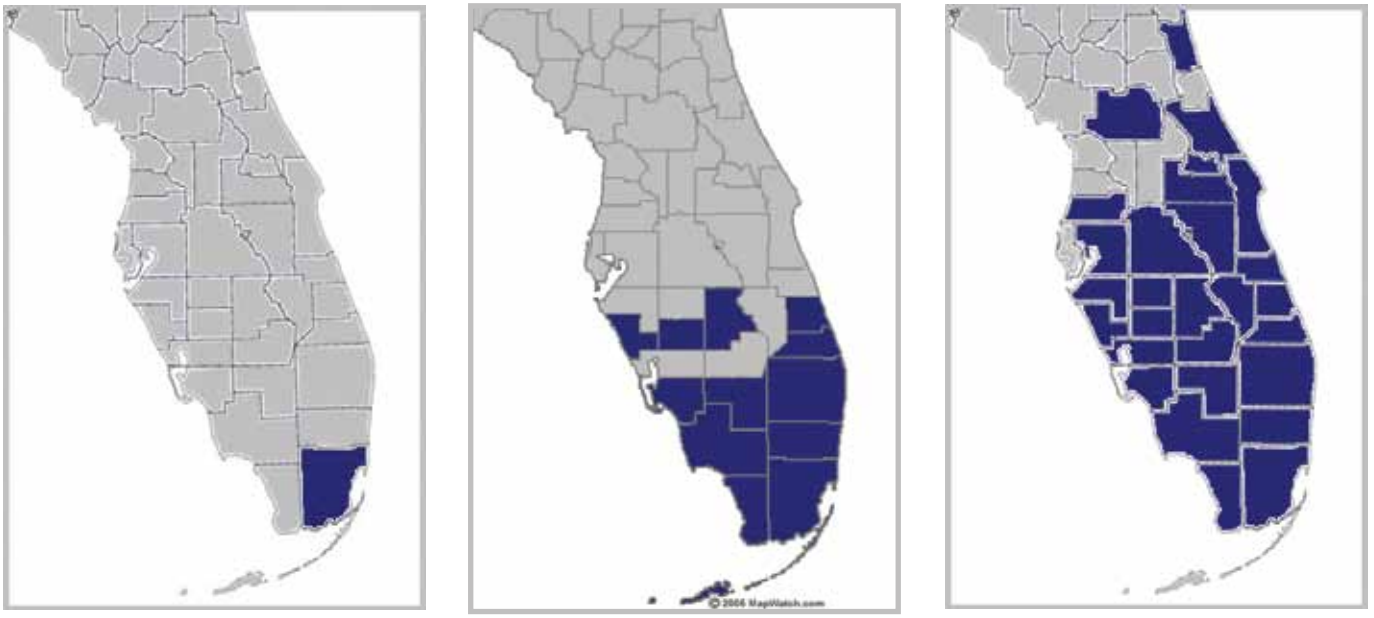

Figure 1. *Maps showing the county-by-county spread of huanglongbing from the original find in Miami-Dade County in August 2005 (left), to June 2006 (middle), to October 2007 (right). Maps compiled by J.D. Yates, UF/IFAS CREC.*

Once we realized the necessity to control ACP, many growers found it difficult to achieve. In the Florida climate, mature citrus trees typically have three main flushes each year – the spring flush, the first summer flush at the start of the rainy season and the late summer flush. However, this does not mean there is no new flush present between these main flushes. On the contrary, new flush can be found throughout the summer rainy season. This new flush is where ACP adults lay eggs and where the nymphs mature. Thus, during the summer, ACP populations can build very quickly because of the presence of new flush and control can be difficult.

Young trees, whether in solid set blocks or resets, are even more of a challenge for ACP control. The vigor of young trees, and their asynchronous flushing, makes them very attractive to ACP. In a reset situation, young trees may actually serve as a refuge for ACP when little or no flush is present on the surrounding mature trees.

Fortunately, research and Extension efforts are paying off, and most growers are now able to manage ACP effectively and keep populations low year-round.

Although ACP control has improved in managed groves, a major difficulty for the industry is the estimated 143,370 acres of abandoned groves in the state. This is equivalent to roughly 25 percent of the managed citrus acreage in Florida. Research has shown conclusively that these abandoned groves serve as refuges for ACP and that ACP routinely move between managed and abandoned groves. Although the data have not been generated, there is no reason to believe that these abandoned acres don't also serve as a reservoir of HLB inoculum.

There is little doubt that these abandoned acres have hindered our industry's efforts to fight HLB. An important question, for which there may be no definitive answer, is whether an inoculum removal strategy can succeed when 25 percent of the industry does nothing? The problem is exacerbated by the fact that abandoned groves are not in a neat contiguous block, but are randomly interspersed among managed groves (Figure 2, page 8). In addition, even if these groves are removed, there will still be backyard trees that can serve as sources of inoculum.

An additional strategy that is being used effectively elsewhere in the fight against HLB is relocating citrus to new areas. This has been seen in Brazil where many growers are moving to the south or north of São Paulo state and leaving the central areas where HLB incidence is heaviest. We've also seen this in China, where the topography allows growers to move over mountain ranges into new valleys free of ACP and HLB, or to higher altitudes where ACP doesn't survive well. Unfortunately, Florida is faced with the situation where we cannot relocate. We must continue to produce citrus where we do today, regardless of ACP or HLB presence, or face a future without citrus.

WHERE WE ARE TODAY

During 2009, two meetings were conducted involving all IFAS Extension and research faculty statewide who work on citrus. The purpose of these meetings was to discuss our current knowledge of HLB and ACP in Florida and to develop guidance for the Florida citrus industry. The outcome of those meetings was the "IFAS Guidance for Huanglongbing (Greening) Management" article published in this magazine (April 2010) and on EDIS (http://edis.ifas.ufl.edu/hs1165).

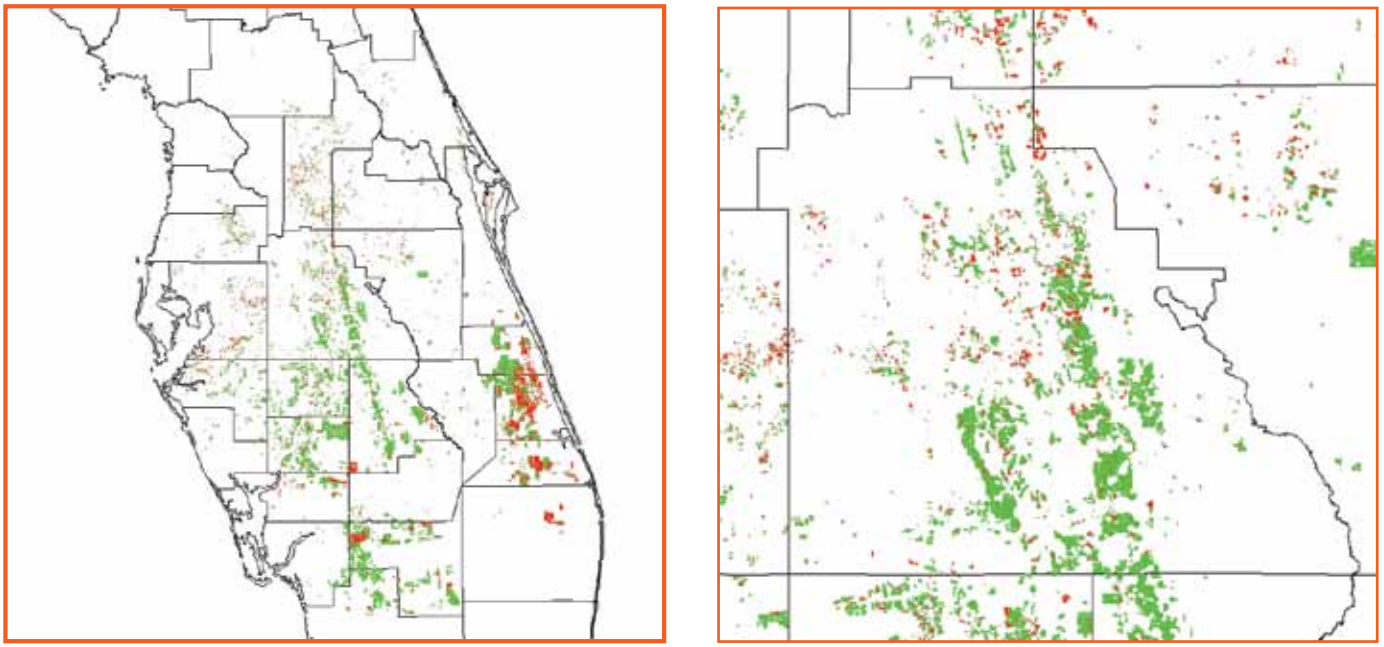

Figure 2. *Images showing the distribution of abandoned groves (red) relative to managed groves (green) for the major citrus producing counties of the Florida peninsula (left) and Polk County (right). GIS images created by A.W. Schumann, UF/IFAS CREC with data from the United States Department of Agriculture, National Agricultural Statistics Service, 2010.*

This article took nearly a year to write and truly represented a consensus of IFAS ideas.

In the guidance document, three scenarios and management guidance for each were outlined – groves with low infection, groves with moderate infection, and groves with high infection. Infection percentages were not defined for these different scenarios because it was believed that each situation is unique and the definition of each scenario would change depending on the circumstances. For example, 3 percent infection may be considered low if you are a large grower or are isolated with no abandoned groves nearby, and you may opt to continue removing trees. However, if you have 3 percent infection and are a small grower with abandoned groves nearby, or you're struggling to manage ACP because you're not in a Citrus Health Management Area (CHMA), 3 percent may be a high infection and you may choose to stop removing infected trees and manage the health of the grove with a foliar nutrition program. That said, efforts are under way to better define different scenarios.

At the International Research Conference on HLB in Orlando in January of this year, several different models were presented to define, from an economics standpoint, when it makes sense to stop removing trees and manage the health of the remaining trees with a foliar nutrition program. Allen Morris, University of Florida-IFAS Citrus Research and Education Center (UF-IFAS CREC) agricultural economist, and Mike Irey, US Sugar Corp. plant pathologist, presented two such models. Although the methods and assumptions used in these models differed, they both concluded that when annual infection rates climb to 4 percent or 5 percent, it makes more sense economically to stop removing trees and attempt to keep the remaining trees productive using a foliar nutrition program.

It is estimated that in 2010 the statewide HLB infection rate had climbed to 18 percent and this is believed to be an *underestimate* (see "*Phytophthora* damage to roots: a potential contributor to decline of HLB-affected trees," *Citrus Industry* May 2011). Today, most growers are concluding that they have reached their economic threshold and can no longer afford to remove infected trees. Arguably, the state, too, may be reaching its economic threshold. The crop forecast of April 8, 2011 was 142 million boxes. If the forecast were reduced by 18 percent — the current underestimate of HLB infection — to 116.4 million boxes, we might be approaching the industry's production viability threshold, estimated by economists to be around 100 million boxes.

MOVING FORWARD

There's no question in anyone's mind that a healthy tree, free of HLB, is the best tree to have in a grove. Short of that, maintaining the lowest possible percentage of HLB-infected trees by rigorous ACP control and scouting and removal of infected trees is optimal and has proven to be the best practice in many citrus-growing areas affected by HLB. Unfortunately, the circumstances in Florida — seven years of poor to no ACP control, abundant flush production, abandoned acreage and geographical constraints — have been insurmountable for many growers, who have concluded that removing infected trees means removing their entire grove and potentially leaving the citrus business. For this reason, many growers around the state have chosen to adopt a strategy of maintaining the health and productivity of their trees through an enhanced foliar nutrition program.

Boyd, in his Orange Hammock Grove near Felda, initiated the original foliar nutrition program. This program has been evolving over time and has changed as feedback has been received from researchers and other growers from around the world. Per acre yields (boxes and pounds solids) have been maintained in the five years since HLB was found in the Felda grove compared with the previous five years (Figure 3, page 9). Studies are under way at the Southwest Florida Research and Education Center (SWFREC) in Immokalee and at a nearby commercial grove to determine which components of Boyd's program are necessary to achieve the effects he's seen. The Immokalee trials were initiated on trees that were much more debilitated (very thin

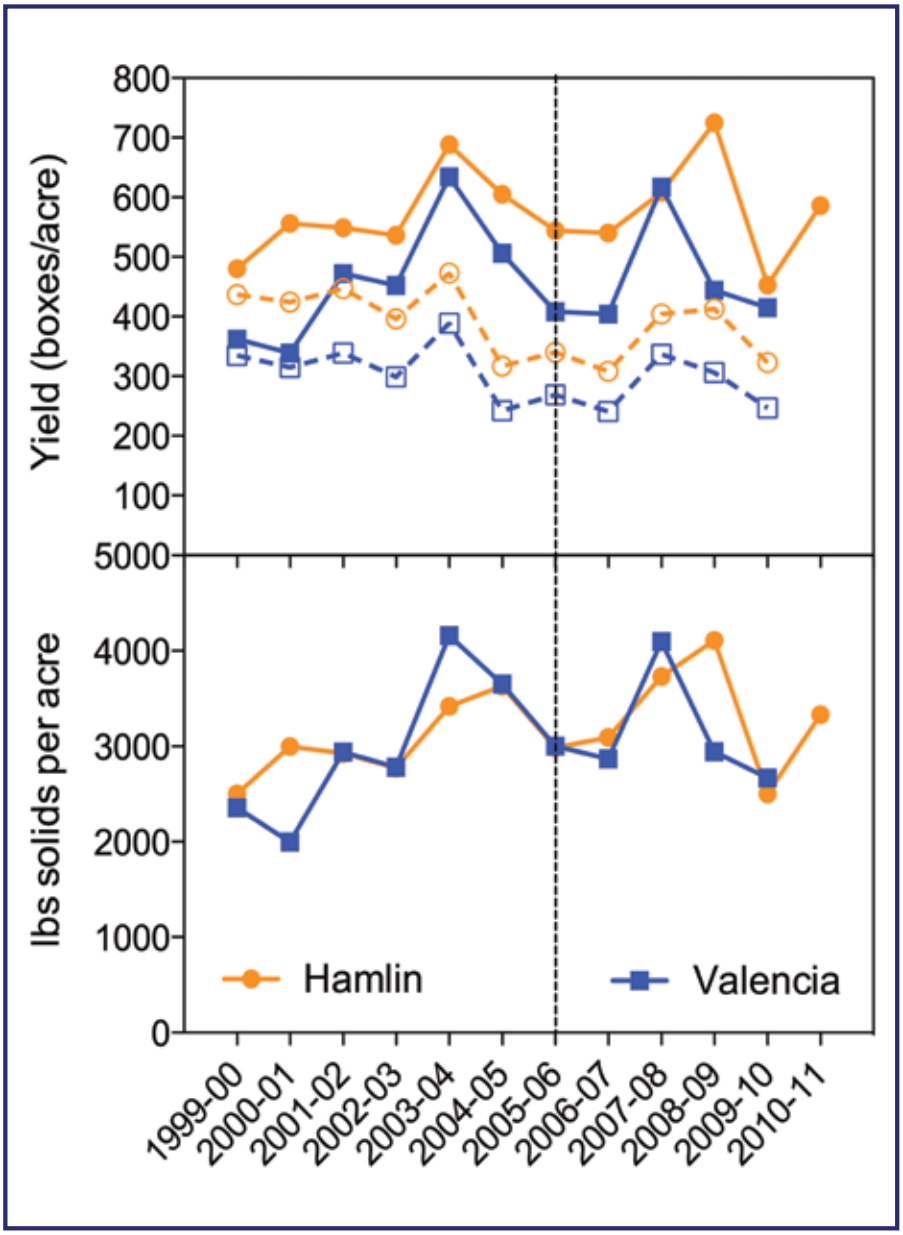

Figure 3. *Yield in boxes per acre (top) and pounds solids per acre (bottom) for Hamlin and Valencia oranges (solid lines) from the 1999-00 harvest season through the 2010-11 harvest season from Maury Boyd's Orange Hammock grove, Felda, Fla. The vertical dashed line indicates the first season harvested with known HLB infection in the grove. The orange and blue dashed lines indicate Hamlin and Valencia, respectively, southern production region average yields. Graphs compiled by T. M Spann, UF/IFAS CREC, data courtesy of Maury Boyd and Florida Agricultural Statistics Service.*

canopies, no fruit) by HLB than the trees at the Orange Hammock grove were in 2006, and the trials have only been under way for two seasons. However, the trees receiving a comprehensive foliar nutrition treatment have dramatically improved visually and are once again setting a crop (Figure 4, page 10).

Recently, Ron Brlansky, UF-IFAS CREC plant pathologist, in an unfunded project collected leaf samples from the trees in the study at SWFREC. He performed a microscopic analysis of the phloem tissue in the leaf petioles from untreated control trees and the comprehensive foliar nutrition trees. He found significantly less phloem plugging — believed to be the primary cause of decline in HLB-infected trees — in trees on the foliar nutrition treatment compared to the untreated controls. Although the exact cause of these differences is unknown at this time, it is possible that improved plant nutrition may be: 1) stimulating the production of new healthy (non-plugged) phloem, 2) limiting the amount or extent of new phloem plugging and collapse, or 3) actually reversing the plugging in existing phloem vessels. Additional samples have been collected and detailed analyses will be performed if funding is available.

Fruit samples have been collected annually since the 2008-09 harvest season from HLB-infected Hamlin and Valencia trees for internal quality analysis. Results conclusively show that full-size asymptomatic fruit can be grown on HLB-infected trees with a good foliar nutrition program and that their internal quality is not compromised by the infection.

A very detailed study is under way at the Citrus Research and Education

Figure 4. *An example of a severely debilitated HLB-infected tree at the SWFREC in Immokalee in February 2008 (left) and two years later in February 2010 (bottom). The tree was treated with K-phite, micronutrients (Mg, Mn, Zn, B and Mo), 13-0-44 KNO_3, 435 oil, and Di-Oxy Solv three times per year coinciding with the spring, first summer and late summer flushes. Photos from Bob Rouse, UF/IFAS SWFREC*

Center in Lake Alfred to determine how different nutrient deficiencies affect development of HLB symptoms and how replacing those nutrients may affect symptom expression. This study is being conducted in sand-culture hydroponics so that very strict control over nutrient levels can be maintained. The study was initiated with very well-nourished nursery trees, so it took nearly a year to develop nutrient-deficiency symptoms. However, the trees displayed good deficiency symptoms of the various nutrients this winter and were graft inoculated with HLB in February. The trees are being carefully monitored to determine which nutrient deficiencies make the trees most susceptible to HLB. Later we will study how the infected trees respond when the various deficient nutrients are replaced.

A small number of projects, from container-grown greenhouse studies to small scale (four-tree plots) and large scale (30 acres) field trials, are currently funded and under way to study the effects of plant nutrition on HLB. These trials will take time to complete and even then may not provide us with all of the answers we are looking for. Unfortunately, the Florida citrus industry cannot wait for all the answers, and management decisions must be made now that will hopefully keep our industry viable until a long-term solution to HLB can be found. In the interim, the authors and all IFAS research and Extension personnel will continue to glean all we can from both scientific replicated trials and anecdotal evidence from grower trials to provide the Florida citrus industry with the best guidance possible.

In summary, seven years of little to no ACP control, a climate conducive to abundant flush production, more than 140,000 acres of abandoned groves, and geographic restrictions have created a perfect storm of HLB in Florida. However, we are learning the importance of proper, balanced nutrition and seeing groves, both infected and healthy, responding positively. We are confident that science will find a solution to HLB and the Florida citrus industry will weather this storm, as it has others in the past, and emerge stronger than ever. But current production levels must be maintained to get there.

Chad Kennedy recently **joined Coldwell Banker Commercial Saunders Real Estate** as a Licensed Real Estate Associate. An

eighth-generation Floridian who comes from a native Florida family, he specializes in land of all types: agriculture, recreational, hunting, ranches, groves and vacant land.